(quartzite, schist), lower Permian limestone and impact melt, which may indicate the boundary of excavation. The 170-km-diameter outermost ring is marked by monomict megablock breccia.

Outside the innermost rim and near the cratering center there are some lobes of imbricate ground surge consisting of volcanic rocks or impact melt. The ground surges appear to be a lot of festoons consisting of a series of arclike ridges with steep outer slopes and gentle inner slopes. The incline of the ridge has a centripetal gradual decrease up to apparent disappearance. The outer edge of the ground surges forms an incomplete ring peak of 18-22 km diameter. The phenomenon indicates that the ground surges are products of oscillatory uplift near the cratering center.

Recently we have found some self-organized textures [3] or chaos phenomena in shock-metamorphic rocks from the Duolun impact crater, such as turbulence in matrices of impact glass, oscillatory zoning, or chemical chaos of spherulites in spherulitic splashed breccia, fractal wavy textures or self-similar wavy textures with varied scaling in impact glass, and crystallite beams shaped like Lorentz strange attractor. The rare phenomena indicate that the shock-metamorphic rocks from Duolun crater are formed far from equilibirum. If it is considerable that impact cratering generates momentarily under high-pressure and superhigh-temperature, occurrence of those chaos phenomena in shock-metamorphic rocks is not surprising.

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GEOCHEMICAL ASPECT OF IMPACT CRATERING: STUDIES IN VERNADSKY INSTITUTE. O. I. Yakovlev and A. T. Basilevsky, Vernadsky Institute of Geochemistry and Analytical Chemistry, Russian Academy of Science, Moscow.

Studies of the geochemical effects of impact cratering at the Vernadsky Institute in collaboration with the Institute of Dynamics of Geospheres, Moscow State University, Leningrad State University, and some other institutions were fulfilled by several approaches.

At the initial stage, three approaches were used: (1) experimental studies of high-temperature vaporization of geological materials (basalts, granites, and so on) in vacuum that was considered as a model of behavior of impact melt and vapor; (2) search of impact-induced geochemical effects in the rock from terrestrial impact craters; and (3) studies of samples of lunar regolith.

The first approach resulted in the conclusion that even at not very high temperatures a selective vaporization of geologic materials occurs and may lead to noticeable changes in elements' contents and ratios. This effect is controlled by the volatilities of individual elements and compounds (sequences of volatilities were determined) as well as their interactions, e.g., realized through the so-called basicity-acidity effect known in igneous petrology.

The second approach resulted in the conclusion that geochemical effects that might be predicted from the experiments and theoretical work are seen in some impact melts, but these observations are not reliable enough and one of the major problems is the uncertainty in estimation of the preimpact target composition.

The third approach was successful in finding such predictable impact-induced effects as partial loss of alkalis, Si, and Fe from regolith and some components of highland breccia.

The next stage of the studies included experiments on quasi-equilibrium vaporization of geological material in Knudsen cells. This study gave reliable data on forms of occurrence of rock-forming elements in the vapor phase, their fugacities, and time-and-temperature sequences of the elements' vaporization, which confirmed, in general, the earlier results from vacuum vaporization experiments. These results provided significant progress in understanding the geochemical effects of impact cratering, but it is evident that impact-induced vaporization is very fast and not equilibrium.

This is why recently a series of experiments using the light gas gun were made. The results show that even at a rather low velocity of impact (5 to 6 km/s) the silicate material involved in the shock displays effects of melting and partial vaporization. It is interesting that with this fast and unequilibrium process the associations of vaporized elements may differ drastically from those that resulted from the slow quasiequilibrium process. For example, refractory U and Th vaporize quite easily. Effects of redox reaction between the materials of target and projectile were found.

The mentioned experimental data show that at small (laboratory experiments) scale geochemical effects do occur in high-velocity impacts. But their role in large-scale natural processes such as heavy bombardment at the early stages of planetary evolution should be clarified in future studies.